

REMARKS

By the present amendment, claims 1 to 5 are pending in the application.

Claims 1, 2 and 4 are independent claims.

§112, ¶2

Claims 1 to 3 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite on the grounds that the “depth” referred to was indefinite.

By the present amendment, claims 1 to 3 have been amended to make the depth of the crystal grains clear.

Claims 1 and 2 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite on the grounds that the “thickness t” was not defined.

By the present amendment, claims 1 and 2 have been amended to define the “thickness t”.

In view of the present amendment, it is respectfully requested that the rejections under 35 U.S.C. §112, second paragraph, be withdrawn.

§103

Claims 1 to 5 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,338,765 to Statnikov (the “ ‘765 patent”).

This rejection is respectfully traversed.

The Present Invention

The present invention relates to a method of improvement of toughness of heat affected zone in a multi-layer welded joint, a fillet welded joint, and a one-pass or several-pass large heat input welded joint. More specifically, the present invention provides a method of improvement of toughness of a heat affected zone in a welded joint of a steel plate wherein said steel plate has a plate thickness t, characterized by subjecting a surface of a heat affected zone formed by a last pass of a multi-layer welded joint of a steel plate to

impacts by an ultrasonic vibration tool or shot peening by ultrasonic vibration steel balls to thereby make an average of a longitudinal axis of crystal grains at a depth of at least 2 mm from the surface of the steel plate in the microstructure adjacent to a fusion line (FL) of a weld metal and a steel plate matrix in said heat affected zone formed by the last pass equivalent to the crystal grain size of the steel plate matrix before the welding at a depth of 1/4 of the thickness t from the surface of the steel plate.

Patentability

The technology disclosed in the ‘ 765 patent relates to ultrasonic impact methods for treatment of welded structures, wherein there is applied the energy of pulses, oscillations and impacts on an exterior surface of a welded structure to rearrange the interior of the structure by plastic deformation, such as,

- a) plastic deformation on the treated work body surface and its internal body volume, typically with a penetration of up to 3 mm into the steel;
- b) residual compression stresses created equal to or higher than the maximum yield of the treated material in the plastic deformation zone;
- c) residual compression stresses historically stored in the area of elastic deformation, typically up to a 5 mm depth in the steel,
- d) pulsed compression stresses induced, typically at a depth of up to 5 mm from the treated surface,
- e) periodic waves of ultrasonic dynamic stresses induced typically to depth of 12 mm under the treated surfaces. (See, e.g., column 6, lines 28-43 of the ‘765 patent).

According to these treatments of the ‘765 patent, the resulting effect creates a rearrangement submicrostructure of grains in treated area, particularly in ferromagnetic

metals. (See: column 10, lines 45-47). Further, white layers (amorphous layers) are formed on the treated body surface and in a narrow under-surface layer, typically 1 μm . (See: column 7, lines 5-7).

However, the '765 patent does not disclose or suggest the feature of "an average of longitudinal axis of crystal grains at a depth of at least 2 mm from the surface of the steel plate in the microstructure adjacent to a fusion line (FL) of a weld metal and a steel plate matrix in said heat affected zone" which is "equivalent to the crystal grain size of the steel plate matrix before welding at a depth of 1/4 of the thickness t from the surface of the steel plate".

In addition there is no disclosure or suggestion of a rearrangement of the microstructure and an improvement of the toughness of heat affected zone in a multi-layer welded joint.

"Toughness" in the present invention is different from "fatigue" in '765 patent, as is well understood in the art. "Toughness" means resistance to the occurrence of the growth of unstable tears with little absorption of energy, i.e., resistance to the occurrence of brittle fracture. On the other hand, "fatigue" means structural failure or tears generated by the application of repeated loads.

The present invention targets to improve toughness (fracture toughness) of the heat affected zone in a multi-layer welded joint, by means of subjecting a surface of a heat affected zone formed by a last pass of multi-layer welded joint of a steel plate to impacts by an ultrasonic vibration tool or shot peening by ultrasonic vibration steel balls to thereby make an average of longitudinal axis of crystal grains at a depth of at least 2 mm from the surface of the steel plate in the microstructure adjacent to a fusion line (FL) of a weld metal and a steel plate matrix in said heat affected zone formed by the last pass (or in the vicinity of the toe portion in the case of a fillet weld) equivalent to the crystal grain

size of the steel plate matrix before the welding at a depth of $1/4$ of the thickness t from the surface of the steel plate.

On the other hand, '765 patent does not disclose or suggest anything about an improvement of toughness by the above mentioned feature of the present invention.

Further, according to the present invention of claim 4, the length of the undercut formed at the toe is made 0.3 mm or less, because if the length of the undercut is 0.3 mm or less, it is difficult for the undercut to become an initiation point of fracture when a tensile stress acts upon the welded joint zone and the fracture toughness value is remarkably improved. See specification, page 10, line 37 to page 11, line 11; page 11, line 25 to page 12, line 2; and Figs. 5 and 6. This feature was not disclosed or suggested in the '765 patent.

Therefore, the present invention is quite different from the technology disclosed in the '765 patent.

It is therefore submitted that claims 1 to 5 are patentable over U.S. Patent No. 6,338,765 to Statnikov.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

KENYON & KENYON LLP

By: John J. Kelly, Jr.
John J. Kelly, Jr.
Reg. No. 29,182

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KENYON & KENYON
One Broadway
New York, NY 10004
Telephone No. (212) 425-7200
Facsimile No. (212) 425-5288
CUSTOMER NO. 26646